METHOD AND ARRANGEMENT FOR AUTOMATICALLY VERIFYING IDENTITIES OF MILK PRODUCING ANIMALS

TECHNICAL FIELD OF THE INVENTION

The present invention generally relates to the field of dairy
5   farming and more specifically the invention relates to methods
and arrangements for automatically verifying identities of milk
producing animals in a milking parlor comprising a row of
stalls.

DESCRIPTION OF RELATED ART AND BACKGROUND OF THE INVENTION

10   Milking parlors with automatic cow identification systems are
known in the prior art, see for example US 5,653,192 issued to
Sheen et al. and US 5,183,008 issued to Townsend et al.

The parlor typically has an identification sensor at the
entrance, which sensor includes a transmitter antenna and a
15   receiver antenna for communicating with a transponder in an
identification tag on a collar around the neck of a cow. The
transponder in the identification tag includes an electronic
oscillator circuit triggered by interrogating electromagnetic RF
radiation from the transmitter antenna and sends back a coded
20   identifying signal in response to the interrogating pulse, which
signal is received by the receiver antenna. The coded
identifying signal is an individual unique identification code
identifying that particular cow.

The cows initially enter the parlor while passing serially
25   through an entrance having the above-mentioned identification
antenna system, and enter then into plural parallel milking
stalls, with the first cow entering the stall in the far end of
the parlor, the second cow entering the adjacent stall, etc.,
and the last cow entering the stall closest to the entrance.

The identification system correlates the cow passing through the identification antenna system with the stall receiving such cow. In this manner, it should be known which cows are in the respective stalls, and in turn milk production can be correlated and tracked for each cow.

A problem arises, however, when a cow passing through the entrance antenna system has lost her tag or has a malfunctioning tag, in which case there is no response signal sent back to the identification antenna system and hence no cow identified. One stall thus has an unidentified cow therein, and the computerized identification system will believe that the next cow is at such stall location.

For example, if the second cow to pass serially through the entrance has a missing tag, such cow will enter the second stall as counted from the far end of the milking parlor. However, the computerized identification system will register a second response coded signal firstly from the third cow, and hence will correlate the third cow to the second stall, i.e. the computerized identification system does not identify the second cow. Likewise, all following cows will be misidentified by one stall location, i.e. correlated to incorrect stalls.

In very small dairy farms, the above problem may not be a significant drawback because the farmers are familiar with the cows and can correct missed identifications manually. However, in large parlors, a misidentification can become a significant problem, particularly when the farmers do not know the cows well enough to correct errors manually.

In addition to absent or malfunctioning tags, misidentifications may be caused when a cow enters with her tag in an unreadable position, or may be due to electronic noise interference, etc. Even if the error or misidentification rate is low, e.g. less than 0.5%, a significant problem can arise depending upon where

such error occurs in the serial flow of cows through the entrance.

For example, if one of the last cows serially entering the parlor has a missing tag, then only the few cows thereafter will also be misidentified. However, if one of the first cows serially entering the parlor has a missing tag, then each of the cows thereafter will be correlated to an incorrect stall.

For a parlor with 20 stalls in a row serving about 1000 cows and with a correct identification probability for each cow entered of 99.5%, the probability that at least one cow in a row of 20 cows is misidentified is $1-0.995^{20} \approx 10\%$, which corresponds to about 5 of the 50 subsequent milking sessions to be performed to complete the milking of the 1000 cows. In average a misidentified cow will lead to 10 misidentifications (20/2) since all cows entered after the misidentified cow will also be misidentified. Hence, in average 50 (5*10) of the 1000 cows, or 5%, will be misidentified.

Besides, there is no knowledge of exactly which the misidentified cows are, and thus if the identification system notes that some error has occurred, i.e. due to the fact that only 19 identifications are made in a particular milking session the dairy farmer may want to omit the identification information of that session in order to be sure that all identifications actually recorded are correct. Thus, only 900 cows (1000-(5*20)), or 90%, will be certainly correctly identified. For larger parlors the correct identification probability will be even lower.

In US 9,59,526 issued to Tucker the above-identified problem has been addressed and solved by means of an identification correction method which compares produced milk weight values and expected milk weight values in a given milking, and performs a correction by shifting at least one or more of the expected milk

weight values relative to the produced milk weight values by at least one stall number, to provide accurate cow identification when there is a misidentified or unidentified cow, such as a cow having a missing identification tag.

5 **SUMMARY OF THE INVENTION**

It is an object of the present invention to address and solve the above-identified misidentification problem in a simple and effective manner and to thus provide an alternative to the solution disclosed in said US 9,59,526.

10 The identification correction method proposed by Tucker has certain limitations. The produced milk weight has to be measured for each cow and compared with an expected milk weight value, derived from earlier milkings of the respective cow. Thus, the method needs a running-in period. Besides, the method relies on 15 that the milk weight values are quite different from cow to cow and that the milk weight produced does not vary especially much from milking to milking.

Further, in a milking parlor of the kind described there may be a risk that a cow is identified, but does not enter the milking 20 parlor. This risk is particularly high at the beginning and at the end of the filling of the parlor with cows, e.g. a cow may be identified before the first cow, which really enters the milking parlor, is identified, or a cow may be identified when the parlor is already full. In such an instance a situation may 25 arise, where the number of identified cows in the stall are equal to the number of milk weights produced, but still the cows are misidentified. The prior art method by Tucker takes not this into account as it is triggered only by the fact that the number of identified cows in the stall are less than the number of milk 30 weights produced.

Still further, the identification correction method by Tucker does not provide any means whatsoever for identifying the cow

with an unidentified identification tag or for verifying/correcting the identity of the cows before milking actually takes place.

Thus, there is a further object of the invention to provide a
5 solution that overcomes the limitations as identified using the identification correction method proposed by Tucker.

These objects among others are, according to the present invention, attained by methods and arrangements as claimed in the appended patent claims.

10 Further characteristics of the invention, and advantages thereof, will be evident from the following detailed description of preferred embodiments of the present invention given hereinafter and the accompanying Figs. 1-5, which are given by way of illustration only, and shall thus not limit the scope of
15 the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic top plan view of a parallel stall milking parlor wherein a preferred embodiment of the present invention is implemented.

20 Fig. 2 is a schematic top plan view of a milking parlor in a herringbone configuration wherein another preferred embodiment of the invention is implemented.

Fig. 3 is a schematic top plan view of a milking parlor in a rotary configuration wherein yet another preferred embodiment of
25 the invention is implemented.

Fig. 4 is a schematic top plan view of a parallel stall milking parlor wherein still another preferred embodiment of the present invention is implemented.

Fig. 5 is a schematic top plan view of a milking parlor in a rotary configuration wherein yet another preferred embodiment of the invention is implemented.

Identical reference numerals are used throughout the Figures to
5   denote identical or similar components, portions, details and the like of the various embodiments.

In the detailed description the milk producing animals are referred to as cows. However, the invention is not limited to cows, but is applicable to any animals having the capability to
10   produce large quantities of milk, such as sheep, goats, buffaloes, horses, etc.

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 1 shows a milking parlor 10 for milking a plurality of cows 12. A double parlor is shown, including a first row of parallel
15   milking stalls 14, and a second row of parallel milking stalls 16, each of which including twelve stalls. Each of the rows 14, 16 is provided with a cow identification station 20, 22 in a respective front end thereof 14a, 16a, through which the cows 12 can pass serially while being identified.

20   A transponder 21 worn on a band around the neck of a cow 12 approaching any of the cow identification stations 20, 22 is energized by a multi-directional electromagnetic field generated by a double antenna loop (not explicitly illustrated) in a portal structure of that cow identification station 20, 22. The
25   transponder, when energized, will transmit unique identification data back to the antenna loop after the electromagnetic field has been removed. A microprocessor 36, connected to the respective identification stations 20, 22, is provided to process the information so that the cow can be identified. For
30   further details of the cow identification station reference is made to the above-identified US 4,798,175, the content of which being hereby incorporated by reference. It shall particularly be

appreciated that the transponder may be worn at other positions of the cow than on a band around the neck.

Alternatively, any other kind of cow identification system may be used in conjunction with the principles of the present invention. Reference is in this respect made to the above-identified US 5,653,192 and US 9,59,526, and to US 5,183,008 issued to Carrano and US 5,028,918 issued to Giles et al., the contents of all of which being hereby incorporated by reference.

After the cows have passed serially through the identification station 20 (or 22) they enter sequentially the row of stalls 14 (or 16) arranged in parallel such that the first identified cow will enter the stall closest to the far end 14b (or 16b) of the row, i.e. the stall denoted 1 in Fig. 1, the second identified cow will enter the stall denoted 2, the n'th identified cow will enter the stall denoted n, and so on until the row is completely full with the last identified cow in the stall closest to the front end 14a (or 16a) of the row. The microprocessor 36 identifies the respective cow and stores the identities in chronological order in a buffer.

When cows have filled the row 14 (or 16) completely they are milked simultaneously. During the milking, measurements of the milk produced by the cows are performed, which typically at least include weights, volumes or flows of the milk produced by each cow. Such information is valuable in the management of the cows, e.g. for controlling their individual feed consumption and for monitoring their health. The milk weights are correlated with the cow identities and are stored by the microprocessor 36. Upon completion of milking, exit gate reels 23 (or 25) are rotated to permit the cows to exit from the milking parlor 10, or the cows may be permitted to leave the row of stalls 14 (or 16) from the far end 14b (or 16b) thereof.

According to the present invention an arrangement for automatically verifying identities of the cows in each of the rows of stalls 14, 16 is provided. The arrangement comprises for each row (i) a first identification member or antenna 24, 30
5   localized to the stall 1 in the far end 14b, 16b of the row for identifying the cow in that stall 1; (ii) a second identification member or antenna 26, 32 localized to the stall in the front end 14a, 16a of the row for identifying the cow in that stall; and (iii) a third identification member 28, 34
10   localized to a stall n between the far and front ends 14a, 14b, 16a, 16b of the row for identifying the cow in that stall n. 16. Preferably, the third identification member 28, 34 is localized to a stall located essentially half-way between the far and front ends of the row.

15   The microprocessor 36, being an integral portion of the verification arrangement, is connected by wire or wireless to each of the identification antennas 24, 26, 28, 30, 32 and 34 for identifying cows from the signals provided by the identification antennas 24, 26, 28, 30, 32 and 34. These
20   identification antennas are similar to the antennas of the identifications stations 20 and 22 in operation, but may be designed smaller and simpler.

Further, the microprocessor 36 is provided with (i) a software module or software code 38 for comparing identifications of the
25   identification antennas 24, 26, 28, 30, 32 and 34 with the identifications from the cow identification stations 20 and 22, (ii) a software module or software code 40 for verifying identities of at least some of the cows, and optionally (iii) a software module or software code 42 for correcting identities.

30   The operation of the verification arrangement will now be described with reference to the row 14 only. Each row of the milking parlor is handled separately by the verification arrangement.

When cows have filled the row 14 completely the arrangement identifies the cows in the first, n'th and last stall, as counted from the far end of the row 14b. The microprocessor 36 then compares, by means of the software code 38, the

5   identifications of the first, second, and third identification antennas 24, 26, 28, respectively, with the first, last and n'th identifications, respectively, from the cow identification station 20. Finally, microprocessor 36 verifies, by means of the software code 40, depending on the comparison made, the

10   identities of at least some of the cows in the row of stalls 14.

Preferably, the verification module 40 verifies the identities of the cows in the stalls located between the far end 14b of the row of stalls 14 and the stall n (with the stall n included) if the identifications of the first and third identification

15   antennas 24, 28 match with the first and n'th identifications from the cow identification station 20 as found by the comparison module 38. Similarly, the verification module 40 verifies the identities of the cows in the stalls located between the stall n (with the stall n included) and the front

20   end 14a of the row of stalls 14 if the identifications of the second and third identification antennas 26, 28 match with the last and n'th identifications from the cow identification station 20.

Such arrangement provides in general for a lower number of

25   misidentified cows since when the identification error occurs among the latter cows at least the cows in stalls 1-n may be identified and verified.

Further, such arrangement provides for the detection of errors even if the number of identifications from the identification

30   station coincides with the number of measured milk weights, i.e. with the number of cows actually being milked. For instance, one cow may have entered the row of stalls without being identified and another cow not entering the row of stalls may have been

erroneously identified in vicinity of the identification station 20. If both errors occur after the first n cows having entered the identifications of cows in the stalls 1-n may still be verified.

Thus, the present invention not only provides for a larger degree of identified cows, but also prevents misidentified cows from being verified. As only milk weights will be correlated with *verified* cow identities there is no risk that a milk weight correlated with a misidentified cow will mislead the dairy farmer when feeding or treating that cow.

Further, the arrangement may be adapted to correct/verify the identities of the cows before the milk weights have been measured, e.g. in connection with the identifications made by the respective identification antennas 24, 26 and 28. In some situations there is important to know the correct identities of the cows before the milking is performed. For example, the milk from cows that are under treatment must not be stored with the milk from healthy cows.

Still further, the invention provides for a certain degree of correction of erroneously made identifications. Several different cases arise depending on the kind of error occurred and where in the sequence the error is made.

Suppose that an unidentified cow (i.e. a cow not identified by the identification station 20) has entered any of the stalls 1-n, firstly it is noted that only eleven identifications from the identification station 20, while milk weights will be measured for twelve cows, i.e. for all stalls in the row. Further, the comparison module 38 will note that the identification of the third identification antenna 28 differs from the n'th identification from the cow identification station 20.

Then the comparison module 38 compares the identifications of the second and third identification antennas 26, 28 with the last and (n-1)'th identifications from the cow identification station 20 and if the identifications of the second and third

5   identification antennas 26, 28 match with the last and (n-1)'th identifications from the cow identification station 20, the correction module 42 corrects the identities of the cows in the stalls located between the stall n (with the stall n included) and the front end 14a of the row of stalls 14 by using the (n-

10   1)'th to last identifications from the cow identification station 20 as the identities of the cows in the stalls located from the stall n to the stall located in the front end of the row of stalls, and finally the verification module 40 verifies the corrected identities only.

15   A special case arises when the first cow entering the row of cows 14 is not properly identified by the identification station 20 and when it can be established that the number of identifications from the identification station 20 is one less than the number of stalls. In this case the comparison module

20   40 will find no match at all, and compares instead the identifications of the second and third identification antennas 26, 28 with the last and (n-1)'th identifications from the cow identification station 20 and if the identifications of the second and third identification antennas 26, 28 match with the

25   last and (n-1)'th identifications from the cow identification station 20, the correction module 42 corrects the identities of the cows in the row of stalls 14 by using (i) the identification from the identification antenna 24 as the identity of the cow in the stall 1, and (ii) the first to last

30   identifications from the cow identification station 20 as the identities of the cows in the stall 2 to the stall located in the front end 14a of the row of stalls 14. Finally, the verification module 40 verifies the corrected identities.

Another case arises if the first cow identified by aid of the identification station 20 does not actually enter the row of stalls 14. Then the eleven last indications of the twelve identifications from the identification station 20 will actually

5   correctly identify the cows in the stalls 1-11 as counted from the far end 14a of the row of stalls. The modules 38, 40, and 42 of the microprocessor 36 may be adapted to correct and verify the identities accordingly. It will be detected that the identifications of the first and third identification members

10   24, 28, respectively, match with the second and (n+1)'th identifications, respectively, from the animal identification station 20. If the arrangement provides for recording of thirteen identifications from the identification station 20 actually the identities of all twelve cows in the row of stalls

15   may be correctly identified.

In whatever situation the identifications from the identification antennas 24, 26, 28 may be used as the identities of the cows in the 1'st, n'th and the stall closest to the front end 14a of the row of stalls 14 by the correction

20   module 40.

Figs. 2 and 3 illustrate two alternative embodiments of the present invention, which are similar to the arrangement of Fig. 1, but are implemented in other kind of milking parlors.

Fig. 2 illustrates an inventive arrangement implemented in a

25   milking parlor in herringbone configuration. The parlor is comprised of two rows of stalls, each including eight stalls.

Fig. 3 illustrates an inventive arrangement implemented in a milking parlor in a rotary configuration. The parlor is comprised of a rotatable circular row of twenty stalls. Here,

30   the cows might be milked in a unbroken manner, and not group wise, but the invention may be implemented by defining virtual front and back ends 14a, 14b and by performing the

identification, comparison, optionally correction, and verification for each revolution of the rotary parlor.

Next, with reference to Fig. 4, which is a schematic top plan view of a parallel stall milking parlor, still another preferred embodiment of the present invention will be described.

This embodiment is similar to the embodiment of Fig. 1, but includes for the row 14 a fourth identification antenna 44 localized to a stall i between the stall 1 and the stall n, preferably essentially half-way between, and a fifth identification antenna 46 localized to a stall q between the stall n and the stall closest to the front end of the row, preferably essentially half-way between.

The comparison module 38 of the microprocessor 36 compares now not only the identifications of the first, second and third identification antennas 24, 26 and 28 with the first, last and n'th identifications from the identification station 20, but compares also the identifications of the fourth and fifth identification antennas 44 and 46 with the i'th and q'th identifications from the identification station 20; and the verification module 40 verifies, depending on the comparison of the five identifications, the identities of at least some of the cows in the row of stalls.

The operation of the different modules 38, 40, 42 may be modified to compare, optionally correct, and verify in a similar manner as described with reference to Fig. 1 but with use of five identification antennas instead of three.

The more identification antennas used the more accurate verification is obtained, and the larger number of correctly identified cows are obtained, but of course to the cost of more expensive equipment and more signaling/computing, which in turn puts higher requirements on the processing capacity of the microprocessor 36. The present inventor has found that for a row

of N stalls, where N is at least six, the inventive arrangement should preferably comprise between three and N/2 identification antennas essentially evenly distributed among the stalls in the row of stalls.

5   Finally, with reference to Fig. 5, which is a schematic top plan view of a milking parlor in rotary configuration, still another preferred embodiment of the present invention will be described.

This embodiment differs from the arrangement illustrated in Fig. 3 in that the first, second, and third identification members 24, 26, 28 are here comprised of a single identification member 24, 26, 28 arranged in a non-rotatable manner, preferably anywhere outside the rotatable circular row of stalls.

The arrangement is adapted to identify the cows in the stalls located at the far end 14b, at the front end 14a, and between the far and front ends 14a, 14b (i.e. the n'th one) of said row of stalls 14 sequentially as the stalls pass by the single identification member 24, 26, 28 during the rotation of the row of stalls 14 while milking the cows therein.

In fact, the arrangement of Fig. 5 may easily be adapted to identify cows in every fourth, every second, or even in each single stall by modifying the software modules 38, 40 and 42 of the microprocessor 36.

It will be obvious that the invention may be varied in a plurality of ways within the scope of the appended patent claims.